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Determination of the Ileal Digestibility of Proteins and Amino Acids from Biscuit Bran and Wheat Gluten in Swine

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

To determine the apparent (AIDCP) and standardized (SIDCP) ileal digestibility coefficients of the protein and the apparent (AIDAA) and standardized (SIDAA) ileal digestibility coefficients of amino acids from biscuit bran and wheat gluten were used six castrated males swine in growth, on average weight from 22 to 60kg, with a T cannula on the terminal ileum, distributed in a randomized block design with three treatments, two periods and two repetitions per period. Each animal was considered a repeat. Treatments consisted of a protein free diet (PFD) for determination of the endogenous loss, PFD + biscuit bran (BB) and PFD + wheat gluten (WG). Each period lasted for six days, five days of adaptation of animals to the diet and 24 hours of collection of ileal digestion.

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The AIDCP of BB and WG were 82.33 and 90.07%, respectively and the SIDCP of BB and WG were 89.17% and 95.60%, respectively. The SIDAA were on average 80.84% (lysine), 83.94% (threonine), 90.57% (methionine + cystine) and 87.15% (valine) to BB. The SIDAA for the WG were on average 91.01% (lysine), 90.97% (threonine), 95.82% (methionine + cystine) and 90.04% (valine). The SID of protein and essential amino acids and non-essential elements identified in this study were on average, respectively, 89.17%, 88.54% and 89.20% of biscuit branand 95.60%, 93.71% and 89.20% of wheat gluten.

Keywords: Alternative food; digests; nutrients; swine.

1. INTRODUCTION

The corn and soybean meal are the main protein and energy ingredients, respectively, used in ration for swine. However, in periods with large climatic variations or increase in exports of these two grains, the cost of production is high, directly influencing the viability of animal production.

So, researchers constantly seek for alternative feeds that can be added in animal feed without damage the nutritional value and quality of the ration, in addition to enabling the flexibility in the formulation of the diet.

The biscuit bran can be used in animal feed as energy food and as a palatalization due to high values of sugars and fats. Characterized as a by-product, it is obtained from the human food industry from not commercialized products that exceeded the period of validity, broken, or with a lack or excess of cooking during processing that for these reasons were not approved by the quality control of the plant (Lima & Ludky [1]). The wheat gluten is a by-product with high protein value which can be used as feed in replacing soybean meal. However, the data in the literature on the nutritional composition and value of digestibility of this product are limited and requires more searches.

The use of by-products in animal feed requires that these should be periodically evaluated for nutritional composition and the coefficients of digestibility of protein and amino acids ensuring that the values provided are in accordance with the requirement of the animal.

Given the above, this work was conducted to determine the apparent and standardized ileal digestibility coefficients of proteins and amino acids from biscuit bran and wheat gluten in diets for swine.

2. MATERIALS AND METHODS

It was used six castrated males swine with the average weight from 22 to 60 kg. For evaluation of the ileal digestibility, the animals were submitted to a surgery for implantation of a cannula T in the terminal ileum held according to the technique described by Donkoh et al. [2].

Twenty-four hours after the surgery, the animals were fed with an initial diet (Table 1) until the beginning of the experiment when they received the experimental diets. The swine were observed daily for a period of 15 days after the surgery, checking their behavior, appetite, the consistency of feces and appearance of the incision.

Table 1. Composition of the starter diet

Ingredients	%
Corn	70.77
Soybean meal	22.60
Soybean oil	1.400
Sugar cane	2.000
Dicalcium phosphate	1.123
Limestone	0.540
Sodium chloride	0.540
L- Lysine HCL	0.435
DL –Methionine	0.105
L-Threonine	0.100
L-Tryptophan	0.015
Mineral premix[1]	0.100
Vitamin Premix[2]	0.210
Antibiotic[3]	0.060
Total	100.000

[1] Supplied per kg of diet: Iron – 64 mg; Zinc – 80 mg; Copper – 9.6 mg; Manganese – 32 mg; Iodine – 0.8 mg; Selenium – 0.29 mg;
[2] Supplied per kg of diet: Vit A – 5.500 IU; Vit. D3 – 1.200 IU; Vit. E – 32 IU; Vit. K3 – 2.4 mg; Vit B1 – 0.8 mg; Vit B2 – 2.0 mg; Vit B6 – 1.6 mg; Vit. B12 – 0.016 mg; Folic Acid – 0.24 mg; Biotin – 0.08 mg; Pantothenic acid – 12 mg; Nicotinic acid – 24 mg; Choline – 500;. Butyl-hydroxytoluene – 0.1 g;
[3] Amoxicillin

Fifteen days after the surgery, the animals were distributed in a randomized block design, four replicates (two replicates/period) in two periods. Each animal is considered a repeat. The animals

were subjected to a period of adaptation to the experimental diets for five days. After the adaptation period, was collected ileal digest for a period of 24 hours. Ending this period, the animals have passed through a period of rest for five days, in which it was delivered a ration based on corn and soybean meal to meet the requirement of animals according to Rostagno et al. [3].

The animals were housed during the experimental period in stalls of concrete with individual nipple drinkers in a room of masonry with earthenware tiles and glass window platforms. Each animal was in a stall. The cleanliness of the stalls and the room was held on a daily basis.

The treatments were: protein free diet (PFD), diet of biscuit bran (BB) and diet of wheat gluten (WG) (Table 2). The PFD was used to determine the loss of endogenous protein and amino acids. The ingredient tested was incorporated to the diet in place of starch. The only source of protein and amino acids was the evaluated ingredient. The experimental diets contained 1% of Celite used as a factor of indigestibility (acid-insoluble ash - AIA). Diets were provided twice a day (7 and 17 hours), on the basis of weight metabolic profile ($kg^{0.75}$).

Table 2. Centesimal composition of experimental diets (% in natural matter)

Ingredients	PFD[1] %	BB[1] %	WG[1] %
Starch	82.41	3.08	62.58
Biscuit Bran	**0.00**	**80.00**	**0.00**
Wheat gluten	**0.00**	**0.00**	**20.00**
Sugar cane	8.00	8.00	8.00
Soybean oil	2.00	2.00	2.00
Corn cob	4.00	4.00	4.00
Dicalcium phosphate	1.350	0.876	1.230
Limestone	0.480	0.385	0.530
Sodium chloride	0.400	0.400	0.400
Mineral premix[2]	0.150	0.100	0.100
Vitamin premix[3]	0.150	0.100	0.100
Antibiotics[4]	0.060	0.010	0.010
Celite (Marker)	1.000	1.000	1.000
Total	100.00	100.00	100.00

[1]PFD: Protein free diet; BB: Biscuit bran; WG: Wheat gluten
[2]Supplied per kg of diet: Iron - 64 mg. Zinc - 80 mg. Copper - 9.6 mg. Manganese - 32 mg. iodine - 0.8 mg. Selenium - 0.29 mg;
[3]Supplied per kg of diet: Vit A - 5.500 IU. vit. D3 - 1.200 IU. vit. E - 32 IU. vit. K3 - 2.4 mg. vit B1 - 0.8 mg. vit B2 - 2.0 mg. vit B6 - 1.6 mg. vit. B12 - 0.016 mg. folic Acid - 0.24 mg. biotin - 0.08 mg. pantothenic acid - 12 mg. nicotinic acid - 24 mg. choline – 500. Butyl-hydroxytoluene – 0.1 g.
[4]Amoxicillin

The digests were collected manually several times a day, in the period of 24 hours, in plastic bags tied directly to the cannula. The samples collected were stored in the freezer. At the end of the experiment, all samples collected from each animal were collected, dried and analyzed for acid-insoluble ash, dry matter, crude protein and amino acids.

The calculations of apparent and standardized ileal digestibility of proteins and amino acids were conducted as described in Sakomura & Rostagno [4].

For the determination of the ileal digestibility coefficients the following formulas were used:

1 - FI1 = factor of indigestibility of diet-test

$FI_1 =$ (% AIA of test diet / % AIA of digestion test)

AIA - acid-insoluble ash

2 – Apparent Ileal digestibility coefficient of crude protein (AIDCP)

AIDCP (%) = [% CP diet - (% CP digest x FI1) / % CP diet x 100]

3 - Standardized Ileal digestibility coefficient of protein (SIDCP)

SIDCP (%) = [{% CP diet - (% CP digest x FI1) - (% of CPe digest x FI2)} x 100] / % CP diet

CPe = endogenous CP excreted in the digest PFD

$FI_{2 =}$ (% AIA PFD diet / % AIA PFD digesta)

FI2 = factor of indigestibility of PFD

4 - Apparent Ileal digestibility coefficient of amino acid (AIDAA)

AIDAA (%) = [(mg AA/ g diet) - (mg AA/ g E1 x FI1) x 100] / Mg AA/g diet

E1 = Digest of diet-test

5 - Standardized Ileal digestibility coefficient of amino acid (SIDAA)

SIDAA (%) = [(mg AA/ g diet) - (mg AA/ g E1 x FI1 - mg AA/ g E2 x FI2) x 100] / mg AA/g diet

E2 = digest of PFD
FI2 = factor of indigestibility of PFD

3. RESULTS AND DISCUSSION

The values of protein and amino acids from biscuit bran obtained in this study (Table 3) were higher than those described by Rostagno et al. [3] and Carvalho [5]. Corassa [6] conducted a compilation of data from published studies with biscuit bran in which has found lower values than those obtained in the present study. Because it is a by-product of the food industry, the nutritional composition varies according to the product used and to the submitted process. This fact reinforces the importance of regular evaluation of by-products used in animal nutrition ensuring a diet with adequate nutritional content.

The levels of protein and amino acids (lysine, methionine, glutamic acid, phenylalanine, tyrosine and valine) of the WG obtained in this study (Table 3) were higher than those described by NRC [7]. However, for the other amino acids: threonine, isoleucine, leucine, histidine and arginine, cystine, alanine, aspartic acid, glycine and serine the values were lower. The variation in nutritional composition may be related to the quality of the grain used and to the type of submitted process. These factors can be pointed out as possible causes in the variation of chemical composition of same ingredients on international and national tables and between Brazilian research.

The AIDCP determined to BB and WG in this study were 82.33 and 90.07%, respectively. These values obtained were higher than those described by Carvalho [5] who found 69.77% for BB and by NRC [7] which received 89% for WG (Table 4).

The AIDAA of BB were on average 69.20% (lysine), 71.40% (threonine), 79.30% (methionine + cystine) and 79.43% (valine). The values of AIDAA obtained in this study were higher than those obtained by Carvalho (2013), except the AID of methionine + cystine which was a little over, 80% (Table 4).

The AIDAA of WG were on average 79.23% (lysine), 78.65% (threonine), 84.41% (methionine + cystine) and 82.39% (valine). The values found in this study were higher than those obtained by the NRC [7] except the AID to valine (83%) (Table 4).

Table 3. Composition of the feed ingredients analyzed (% in natural matter)

Nutrients	Biscuit brain	Wheat gluten
Protein	16.130	75.580
Lysine	0.400	1.550
Threonine	0.450	1.710
Methionine	0.240	1.450
Cystine	0.210	1.140
Methionine + Cystine	0.450	2.590
Alanine	0.510	1.850
Arginine	0.620	2.600
Aspartic Ac	0.610	2.240
Glutamic Ac	5.250	28.460
Glycine	0.570	2.410
Histidine	0.270	1.370
Isoleucine	0.530	2.420
Leucine	1.050	4.870
Phenylalanine	0.790	3.940
Serine	0.770	3.580
Tyrosine	0.490	2.840
Valine	0.780	3.270
Phenylalanine + Tyrosine	1.280	6.780
Glycine + Serine	1.340	5.990

Table 4. Apparent ileal digestibility coefficients (%) of protein and amino acids of certain ingredients with growing pigs

Nutrients	Apparent ileal digestibility coefficients (%)	
	Biscuit brain	Wheat gluten
Protein	82.33	90.07
Lysine	69.20	79.23
Threonine	71.40	78.65
Methionine	86.62	91.52
Cystine	75.93	83.13
Methionine + Cystine	79.30	84.41
Alanine	74.46	80.96
Arginine	83.44	89.62
Aspartic Ac	77.48	86.78
Glutamic Ac	94.87	96.94
Glycine	75.58	83.43
Histidine	86.60	92.05
Isoleucine	82.69	87.47
Leucine	86.89	91.99
Phenylalanine	88.30	92.63
Serine	83.67	90.87
Tyrosine	81.69	85.97
Valine	79.43	82.39
Phenylalanine + Tyrosine	85.98	90.39
Glycine + Serine	79.96	87.67

The SIDCP of BB and WG in this study were 89.17 and 95.60%, respectively. The values obtained in this study were higher than those

obtained by Carvalho [5] when work with BB (88.17%) and NRC [7] for WG (91%) (Table 5).

The SIDAA of BB were on average 80.84% (lysine), 83.94% (threonine), 90.57% (methionine + cystine) and 87.15% (valine). The values obtained in the present study were higher than values of SID of threonine (83.5%), methionine + cystine (86.1%) and lower than the lysine (84.0%) and valine (87.9%) obtained by Carvalho (2013) (Table 5).

Table 5. Standardized ileal digestibility coefficients (%) of proteins and amino acids in the food ingredients determined on growing pigs

Nutrients	Standardized ileal digestibility coefficients (%)	
	Biscuit brain	Wheat gluten
Protein	89.17	95.60
Lysine	80.84	91.01
Threonine	83.94	90.97
Methionine	91.99	96.17
Cystine	88.08	93.37
Methionine + Cystine	90.57	95.82
Alanine	84.89	92.02
Arginine	89.35	95.37
Aspartic Ac	87.58	98.55
Glutamic Ac	96.77	98.37
Glycine	86.72	93.77
Histidine	91.39	96.03
Isoleucine	88.44	92.86
Leucine	91.84	96.29
Phenylalanine	92.77	96.28
Serine	90.37	96.38
Tyrosine	89.85	93.10
Valine	87.15	90.04
Phenylalanine + Tyrosine	91.74	95.21
Glycine + Serine	88.69	95.26

The periodic assessment of bromatological composition and digestibility of biscuit bran important to ensure the appropriate formulation of rations. This ingredient has high energy value (Rostagno et al. [3]) and high palatability which contributes to improve the acceptance of the ration especially in the post-weaning. The values of standardized ileal digestibility coefficients obtained from the BB shows that despite being a by-product, the food shows good quality and good use.

The SIDAA of WG were on average 91.01% (lysine), 90.97% (threonine), 95.82% (methionine + cystine) and 90.04% (valine) (Table 5). The values obtained in this study were higher than those described by NRC [7] and Urbaityte et al. [8].

The values of bromatological composition and the apparent and standardized ileal digestibility coefficients of wheat gluten obtained in this study are of great relevance for animal nutrition since there are few studies in the literature about this ingredient. This study proved that this ingredient has high protein content and high value of digestibility, as described in the literature (Filipetto [9]). As an ingredient with high cost, it is important that the values provided are correct to avoid waste.

Some factors may have influenced the values obtained in this study, such as: composition of the sample evaluated, the methodology employed and the amount of food included in the PFD. Despite the difference found, the values of bromatological composition and digestibility coefficients can be used in the formulation of diets provided to swine.

4. CONCLUSION

The ileal digestibility standardized coefficients for protein and essential and non-essential amino acids determined in this study were on average, respectively, 89.17%, 88.54% and 89.20% of biscuit bran and 95.60%, 93.71% and 89.20% of wheat gluten.

ETHICAL APPROVAL

Approved by the ethics committee of animal use/ Federal University of Viçosa (UFV) in protocol number 24/2007.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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